consists of telephone poles and associated hardware such as anchors and guys. Buried structure consists of trenches.[444] Underground structure consists of trenches, conduit, manholes, and pullboxes. Underground cable is placed underground within conduits for added support and protection. Structure costs include the initial capital outlay for physical material associated with outside plant structure, including manholes; conduit, trenches, poles, anchors and guys, and other facilities; the capitalized cost for supplies, delivery, provisioning, right of way fees, taxes, and any other capitalized costs directly attributable to these assets; and the capitalized cost for the labor, engineering, and materials required to install these assets. For example, buried and underground structure costs include capitalized labor, engineering, and material costs for such activities as plowing or trenching, backfilling, boring cable, and cutting and restoring asphalt, concrete, or sod, or any combination of such activities. Generally, the type of structure that is placed will vary depending on the type of plant installed, i.e., the plant mix.

210. As noted above, the model uses structure cost tables that identify the per-foot cost of structure by type (aerial, buried, or underground), loop segment (distribution or feeder), and terrain conditions (normal, soft rock, or hard rock), for each of the nine density zones. For aerial structure, the cost per foot that is entered in the model is calculated by dividing the total installed cost per telephone pole by the distance between poles. We tentatively concluded that we should use, with certain modifications, the estimates in the NRRI Study for the per-foot cost of aerial, underground, and buried structure.[445] We noted that, in general, these estimates are derived from regression equations that measure the effect on these costs of density, water, soil, and rock conditions.

211. In the *Inputs Further Notice*, we rejected the HAI and BCPM sponsors' default input values for structure costs because they were based upon the opinions of their respective experts and lacked supporting data that allowed us to substantiate these values.[446] As noted above, we have received other structure cost data from a number of LECs, as well as AT&T, including data received in response to the structure and cable cost survey and data submitted in *ex parte* filings.

212. In the *Inputs Further Notice*, we tentatively decided to use the regression equation for aerial structure in the NRRI Study as a starting point for aerial structure input

[444] When a plow is used to place buried cable, a separate trench is not required.

[445] *Inputs Further Notice* at para. 106.

[446] *Inputs Further Notice* at para. 105.

values.[447] We proposed to use this equation to develop proposed input values for the labor and material cost for a 40-foot, class-four telephone pole. We developed separate pole cost estimates for normal bedrock, soft bedrock, and hard bedrock.[448] The regression coefficients estimate the combined cost of material and supplies. The NRRI Study reports that the average material price for a 40-foot, class-four pole is $213.94.[449] We noted that this estimate is very close to results obtained from the data submitted in response to the *1997 Data Request*.

213. We also tentatively concluded that we should add to these estimates the cost of anchors, guys, and other materials that support the poles, because the RUS data from which this regression equation was derived do not include these costs.[450] As we noted, Gabel and Kennedy used the RUS data to develop the following cost estimates for anchors, guys and other pole-related items: $32.98 in rural areas; $49.96 in suburban areas; and $60.47 in urban areas.[451] We tentatively concluded that these are reasonable estimates for the cost of anchors, guys, and other pole-related items.[452]

214. We also explained, in the *Inputs Further Notice*, that in order to obtain proposed input values that can be used in the model, it is necessary to convert the estimated pole costs into per-foot costs for each of the nine density zones.[453] For purposes of this computation, we proposed to use, for density zones 1 and 2, the per-pole cost that we have estimated for rural areas, based on the NRRI Study; for density zones 3 through 7, the per-pole cost for suburban areas; and for density zones 8 and 9, the per-pole cost for urban areas. We then divided the estimated cost of a pole by the estimated distance between poles. We proposed to use the following values for the distance between poles: 250 feet for density zones 1 and 2; 200 feet for zones 3 and 4; 175 feet for zones 5 and 6; and 150 feet for zones 7, 8, and 9. For the most part, these values are consistent with both the HAI and BCPM defaults.

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[447] *Inputs Further Notice* at para. 107. This regression equation was set forth in Appendix D, section III.A of the *Inputs Further Notice*.

[448] *See Inputs Further Notice*, Appendix D, section III.A.

[449] *Inputs Further Notice* at para. 107 n. 206 *citing* NRRI Study at 51, Table 2-11.

[450] *Inputs Further Notice* at para. 108.

[451] *Inputs Further Notice* at para. 108 n. 208 *citing* NRRI Study at 55, Table 2-14.

[452] *Inputs Further Notice* at para. 108.

[453] *Inputs Further Notice* at para. 110.

215. We also tentatively concluded that we should adopt a methodology to estimate the cost of underground structure that is similar to the one we proposed for the cost of aerial structure.[454] We tentatively concluded that we should use the equation set forth in Appendix D of the *Inputs Further Notice* as a starting point for this estimate.[455] We proposed to use this equation to develop proposed input values for the labor and material cost for underground cable structure. We developed separate cost estimates for underground structure in normal bedrock, soft bedrock, and hard bedrock for density zones 1 and 2.[456]

216. We also tentatively concluded that we should use the modified equation for estimating the cost of 24-gauge buried copper cable and structure to estimate the cost of buried structure.[457] We determined that it is necessary to modify this equation because estimates derived from it include labor and material costs for both buried cable and structure.[458]

217. Finally, we determined that, because the RUS data are from companies that operate only in density zones 1 and 2, we were unable to develop estimates from the regression equation for density zones 3 through 9 for underground and buried structure.[459] We tentatively concluded, therefore, that we should derive cost estimates for density zones 3 through 9 by extrapolating from the estimates for density zone 2. We sought comment on alternative methods for estimating structure costs for density zones 3 through 9.

b. Discussion

218. We affirm our tentative conclusions to use the regression equation for aerial structure in the NRRI Study as a starting point for the cost estimate for aerial structure; to use the regression equation for underground structure in the *Inputs Further Notice* as a starting point for the cost estimate for underground structure for density zones 1 and 2; and to use the

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[454] *Inputs Further Notice* at para. 111.

[455] *See Inputs Further Notice*, Appendix D, section III.B. This regression equation is based on the RUS data, but was developed after the publication of that report. The NRRI Study does not set forth a regression equation for estimating the cost of underground structure.

[456] This regression equation was developed using underground cost data for density zones 1 and 2. The variable in this equation that represents the density zone of the geographic area in which the underground costs are incurred is not statistically significant at any standard level of significance.

[457] This equation is set forth in Appendix D, section III.C of the *Inputs Further Notice*.

[458] *See Inputs Further Notice*, Appendix D, section III.C.

[459] *Inputs Further Notice* at para. 112.

regression equation for the cost of 24-gauge buried copper cable and structure, as modified below, to estimate the cost of buried structure for density zones 1 and 2.[460] Concomitantly, we affirm our tentative conclusion to add to the estimates for aerial structure the costs of anchors, guys, and other materials that support the poles. As we explained in the *Inputs Further Notice*, the RUS data from which this regression equation was derived do not include these costs. We also adopt the following values we proposed in the *Inputs Further Notice* for the distance between poles: 250 feet for density zones 1 and 2; 200 feet for zones 3 and 4; 175 feet for zones 5 and 6; and 150 feet for zones 7, 8, and 9.

219. As noted above, several commenters advocate that the input values we adopt for structure costs reflect company-specific data. For the reasons enumerated above, we reject the use of the company-specific data we have received to estimate the nationwide average input values for structure costs to be used in the model.

220. Notwithstanding this conclusion, we find that it is unnecessary to extrapolate cost estimates for underground and buried structure for density zones 3 through 9 as we proposed. At the time of the *Inputs Further Notice*, we believed the extrapolated data were the best data available to us at the time for density zones 3 through 9 although we noted our preference to use data specific to those density zones.[461] Upon further examination, we find that cost data, which include values for density zones 3 through 9, submitted by various state commissions for use in this proceeding are more reliable than the extrapolated data.[462] Specifically, we reviewed structure cost data from North Carolina, South Carolina, Indiana, Nebraska, New Mexico, Montana, Minnesota, and Kentucky. These data reflect structure costs designed for use in the HAI and BCPM models.[463]

221. The structure costs submitted by the state commissions have values for normal rock, soft rock, and hard rock for density zones 3 through 9. We adopt as the buried and

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[460] *See* paragraphs 126-132 for a discussion of the development of the equation for buried structure.

[461] *Inputs Further Notice* at para. 112.

[462] In the *Universal Service Order*, we determined that states could submit their own cost studies to serve as the basis for calculating federal universal service support in their states, if those studies met the criteria for forward-looking economic cost determinations. In sum, we required that such cost studies must be based on forward-looking economic cost principles and supported by publicly available data and computations. In order for the Commission to accept a state cost study for these purposes, we also required that the study be the same cost study that is used by the state to determine intrastate universal service support levels pursuant to 254(f) of the Act. *See Universal Service Order*, 12 Fcc Rcd at 8912-16, paras. 248, 250-51. The Commission subsequently adopted the Joint Board's recommendation to estimate forward-looking costs using a single national model. *See Seventh Report & Order*, 14 FCC Rcd at 8103.

[463] The RUS data underlying the NRRI Study reflect structure costs for density zones 1 and 2.

underground structure cost input values for these density zones weighted average structure costs developed from these data based on the number of access lines for the companies to which the state decisions regarding the submitted structure costs apply. We find that these weighted averages represent reasonable estimates for buried and underground structure costs in normal, soft, and hard rock conditions for density zones 3 through 9.

222. Apart from the criticism of the extrapolation of structure costs for density zones 3 through 9 from the estimates for density zone 2,[464] the comments we have received regarding the values we proposed for structure costs vary as to the type of structure the commenters address and vary as to the position they take on the reasonableness of the estimates.[465] BellSouth states that the values we adopt for aerial structures are "fairly representative of BellSouth's values" but claims that, based on a comparison to its actual data, the values for underground and buried structure are too low.[466] Cincinnati Bell states that the values we adopt for underground structure never vary from Cincinnati Bell's actual costs by more than 15 percent.[467] Sprint claims that our proposed cost of poles are understated but the costs of anchor and guys appear to be reasonable.[468] SBC claims that its actual weighted cost of a 40 foot pole is inconsistent with the loaded cost from the NRRI Study. SBC asserts, however, that the NRRI-specified cost is more closely aligned with SBC's anchor and guy costs.[469] We find that, given this divergence of positions, the support in the record for some of our proposed values, and lack of back-up data to support the arguments opposing our proposals, on balance, the structure cost estimates we adopt for aerial, underground, and buried structure for density zones 1 and 2 are reasonable. Moreover, we find it is reasonable to use the values we adopt for density zones 3 through 9. As we discussed above, these values reflect cost data for density zones 3 through 9 and have been submitted to us by state commissions for use in this proceeding. These values are more reliable than those derived

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[464] *See* GTE *Inputs Further Notice* comments at 53.

[465] GTE contends that the model should rely on two sizes of poles in estimating aerial costs. GTE *Inputs Further Notice* comments at 51. GTE also recommends that the calculation of the number of poles for a given length of facility be modified. We find that there is insufficient evidence on the record at this time with regard to the type of pole used in a particular density zone to make a determination as to GTE's first recommendation. We may evaluate this, among other factors, and provide parties an opportunity to submit additional evidence on the record in the upcoming proceeding on future changes to the model. We also find that GTE's second recommendation represents a platform change which may be considered in the upcoming proceeding on future changes to the model.

[466] GTE *Inputs Further Notice* comments at 51.

[467] Cincinnati Bell *Inputs Further Notice* comments at 4.

[468] Sprint *Inputs Further Notice* comments at 30-31.

[469] SBC *Inputs Further Notice* comments at 10.

through the extrapolation of data reflecting density zones 1 and 2, and for the reasons discussed above, the company-specific data submitted on the record.

223. In reaching these conclusions, we note that AT&T and MCI advocate that we adjust the regressions used to estimate structure costs to reflect the buying power of large non-rural LECs.[470] We find that, because AT&T and MCI did not provide any data to support such a determination, the record is insufficient to determine that such an adjustment is necessary. We also reject AT&T and MCI's claim that the costs of underground structure are excessive because they fail to exclude manhole costs from the costs of underground distribution.[471] Contrary to AT&T and MCI's assertion, we find that manhole costs are necessary to allow for splicing when the length of the distribution cable exceeds minimum distance criteria adopted by the model.

224. Finally, we note, as described more fully above, that we have made adjustments to certain of the regression equations in the *Inputs Further Notice* from which we estimate structure costs in order to address certain of the criticisms reflected in the comments and improve the regression equations accordingly.[472]

225. LEC Loading Adjustment. In the *Inputs Further Notice*, we tentatively concluded that we should add a loading of ten percent to the material and labor cost (net of LEC engineering) for aerial, underground, and buried structure because the cost of LEC engineering was not reflected in the data from which Gabel and Kennedy derived their estimates.[473] We find that, based on the record before us, the LEC engineering adjustment is appropriate and the proposed level of the adjustment is reasonable. In reaching this conclusion, we reject at the outset the position of those commenters advocating that the adjustment be based on company-specific data. As we explained above, we find such data are not the most reliable data on the record.

226. As with the LEC adjustment proposed for cable costs discussed above, there is a general consensus on the record among the commenters that an adjustment is necessary. We find, therefore, that an adjustment to reflect the cost of LEC engineering is appropriate. Beyond the general claim that we should adopt company-specific data, there is divergence among the commenters regarding the appropriate level of this adjustment. GTE claims that the adjustment should be greater than 10 percent based on a comparison to its data for buried

470 AT&T and MCI *Inputs Further Notice* comments at 23.

471 AT&T and MCI *Inputs Further Notice* comments at 24.

472 *See supra* at paragraphs 133-138.

473 *Inputs Further Notice* at paras. 109, 111, 114. We note that this adjustment is consistent with that made to aerial, underground, and buried cable.

plant.[474] SBC agrees that 10 percent is appropriate for aerial and buried structure but too low for underground structure.[475] SBC proposes a loading factor of 20 percent instead for underground structure. Based on our review of the information, it is our judgement that the 10 percent adjustment is the most reasonable value on the record before us to reflect the cost of LEC engineering.[476]

7. Plant Mix

a. Background

227. In the *Inputs Further Notice*, we explained that plant mix, i.e., the relative proportions of different types of plant in any given area, plays a significant part in determining total outside plant investment.[477] This is because the costs of cable and outside plant structure differ for aerial, buried, and underground cable and structure. The model provides three separate plant mix tables, for distribution, copper feeder, and fiber feeder, which can accept different plant mix percentages for each of the nine density zones.

228. Distribution Plant. In the *Inputs Further Notice*, we tentatively selected input values for distribution plant mix that more closely reflected the assumptions underlying BCPM's default values than HAI's default values.[478] Specifically, we tentatively proposed input values, for the lowest to the highest density zones, that range from zero percent to 90 percent for underground plant; 60 to zero percent for buried plant; and 40 to ten percent for aerial plant. We tentatively selected input values that more closely reflected the assumptions underlying the BCPM default values because the model does not design outside plant that contains either riser cable or block cable, so we did not believe it would be appropriate to

[474] GTE *Inputs Further Notice* comments at 53.

[475] SBC *Inputs Further Notice* comments at 10-11.

[476] *See supra* paragraph 165.

[477] *Inputs Further Notice* at para. 116.

[478] In the *Inputs Further Notice*, we distinguished the BCPM default values for distribution plant from those reflected in the HAI model. *Inputs Further Notice* at para. 47. As we explained, the BCPM default values for distribution plant assume that there is no underground plant in the lowest density zone and the percentage increases with each density zone to 90 percent underground distribution plant in the highest density zone. In contrast, the HAI default values for distribution plant mix place no underground structure in the six lowest density zones and assume that only 10 percent of the structure in the highest density zone is underground. The BCPM default values assume there is no aerial plant in the highest density zone in normal and soft rock terrain, and 10 percent aerial plant in hard rock terrain. In contrast, the HAI default values assume that there is significantly more aerial cable, 85 percent, in the highest density zone, but notes that this includes riser cable within multi-story buildings and "block cable" attached to buildings, rather than to poles.

assume that there is as high a percentage of aerial plant in densely populated areas as the HAI default values assume. Moreover, although our proposed plant mix values assumed somewhat less underground structure in the lower density zones than the BCPM default values, we disagreed with HAI's assumption that there is very little underground distribution plant and none in the six lowest density zones.

229. Feeder Plant. We tentatively selected input values for feeder plant mix that generally reflect the assumptions underlying the BCPM and HAI default plant mix percentages, with certain modifications.[479] We tentatively proposed input values, for the lowest to the highest density zones, that range from five percent to 95 percent for underground plant; 50 to zero percent for buried plant; and 45 to five percent for aerial plant. Based on our preliminary review of the structure and cable survey data,[480] the proposed values assume that there is no buried plant in the highest density zone. In contrast to the BCPM defaults, the proposed values assume there is some aerial plant in the three highest density zones. We tentatively found that it is reasonable to assume that there is some aerial feeder plant in all density zones, as HAI does, particularly in light of our assumption that there is no buried feeder in the highest density zone, where aerial placement would be the only alternative to underground plant. Although the HAI sponsors had proposed plant mix values that vary between copper feeder and fiber feeder, they offered no convincing rationale for doing so. We tentatively concluded that, like the BCPM defaults, our proposed plant mix ratios should not vary between copper feeder and fiber feeder.

230. Finally, we sought comment on alternatives to the nationwide plant mix input values we tentatively adopted. As we explained, the Commission tentatively concluded, in the *1997 Further Notice*, that plant mix ratios should vary with terrain as well as density zones.[481] Because the model does not provide separate plant mix tables for different terrain conditions, however, the nationwide plant mix values we proposed do not vary by terrain. We noted that one method of varying plant mix by terrain would be to add separate plant mix tables, as

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[479] As we explained in the *Inputs Further Notice*, the default plant mix percentages for feeder plant are generally similar in the BCPM and the HAI models. *Inputs Further Notice* at para. 120. Although the BCPM default values vary between normal or soft rock terrain and hard rock terrain, as noted above, and the HAI default values differ between copper and fiber feeder, the plant mix ratios across density zones are similar. For example, both the BCPM default values and the HAI default values assume that there is only five or ten percent of underground feeder plant in the lowest density zone. The HAI defaults assume there is somewhat more aerial feeder cable than the BCPM defaults, except for fiber feeder cable in the four lowest density zones. The BCPM defaults assume there is no aerial feeder plant in the three highest density zones, except in hard rock terrain. Despite these differences, the relative amounts of aerial and buried plant across density zones are generally similar.

[480] *See Inputs Further Notice*, Appendix C.

[481] *1997 Further Notice* at para. 122.

there are in BCPM, to the model. We observed that, while the BCPM model provides separate plant mix tables, the BCPM default values reflect only slightly more aerial and less buried plant in hard rock terrain than in normal and soft rock terrain. We suggested that another method of varying plant mix would be to use company-specific or state-specific input values for plant mix, as advocated by the BCPM sponsors and other LECs.

231. We also noted that, although we had generally chosen not to use study area specific input values in the federal mechanism, and we recognized that historical plant mix ratios may not reflect an efficient carrier's plant type choice today, historical plant mix might reflect terrain conditions that will not change over time. We explained that our analysis of current ARMIS data reveals a great deal of variability in plant mix ratios among the states. To that end, we recognized that US West had proposed an algorithm in certain state proceedings for adjusting plant mix to reflect its actual sheath miles as reported in ARMIS.[482] We sought comment on a modified version of this algorithm as an alternative to nationwide plant mix values.[483]

b. Discussion

232. As explained above, although we tentatively chose to adopt nationwide plant mix values, we presented and sought comment on an alternative algorithm based on sheath miles reported in ARMIS to develop plant mix values. Consistent with that alternative, GTE asserts that company-specific plant mix should be used instead of nationwide input values.[484] Similarly, Sprint contends that company-specific or state-specific plant mix values should be

[482] Structure distance, also known as route distance, measures the distance of the pole line or the trench. Sheath distance measures cable distance. If there is only one cable along a particular route then structure distance and sheath distance are equal. When, however, there is more than one cable along a route, sheath distance will be a multiple of the structure distance.

[483] The proposed algorithm uses ARMIS 43-08 data on buried and aerial sheath distances and trench distances to allocate model determined structure distance between aerial, buried, and underground structures. The first step is to set the underground structure distance equal to the ARMIS trench distance and to allocate that distance among the density zones on the basis of the nationwide plant mix defaults. Then an initial estimate of aerial plant is calculated as the sum of the synthesis model structure distances by density zone multiplied by the nationwide aerial plant mix defaults. A second estimate of aerial plant is calculated by multiplying structure distance less trench miles by the aerial percentage of total ARMIS sheath miles. Then an adjustment ratio is calculated by dividing the second estimate by the initial estimate. This adjustment ratio is then applied to each density zone to adjust the nationwide default so that the final synthesis model plant mix reflects the study area specific plant mix. The buried plant mix percentage is determined as a residual equal to one minus sum of the underground and aerial percentages.

[484] GTE *Inputs Further Notice* comments at 58.

used.[485] US West asserts that the model should utilize study-area specific plant mix values that are available in ARMIS as a starting point for plant mix inputs in the model.[486]

233. We find, however, as discussed more fully below, because companies do not report aerial and buried route miles in ARMIS, that it is not possible to develop plant mix factors directly from these data at this time. Moreover, we note that the record does not reflect company-specific plant mix values for all companies, nor has any commenter presented a methodology that recognizes the fact that plant mix varies across density zones and allocates it accordingly. In sum, we conclude that neither company-specific nor ARMIS-derived data represent reasonable alternatives to the use of nationwide inputs. We find, therefore, that the use of nationwide inputs is the most reasonable approach in developing plant mix values on the record before us.

234. US West claims that the plant mix algorithm we proposed places too much plant in aerial. US West traces this flaw to several alleged errors in the plant mix algorithm.[487] US West claims that the algorithm erroneously double weights the model plant mix. This is not an error as US West claims. Because the model results used in US West's analysis are based on the low aerial distribution input, we find that the double weight should result in low levels of aerial construction rather than high levels of aerial construction. US West also identifies several formulaic errors.[488] We find these errors attributable, however, to US West's lack of understanding of how the proposed algorithm works.[489] We agree, however, with US West that the high aerial results do appear to be a function of incorrectly weighting aerial plant. We find that this problem is a function of treating the aerial plant mix factor as a residual rather than directly estimating an aerial factor. Given this flaw, we conclude that we should not adopt the plant mix algorithm on which we sought comment.

235. As noted above, we sought comment on alternatives to nationwide plant mix input values.[490] US West has proposed two algorithms. As explained below, we find that

[485] Sprint *Inputs Further Notice* comments at 34.

[486] US West *Inputs Further Notice* comments at 32-36.

[487] US West *Inputs Further Notice* comments, Attachment D.

[488] US West *Inputs Further Notice* comments, Attachment D.

[489] For example, the ARMIS buried ratio is not the ratio of model buried to the sum of model underground and model aerial as US West claims, but rather the ratio of model buried to the sum of model buried and model aerial. US West claims that the underground ratio is the ratio of ARMIS to model sheath miles. This is incorrect. It is the ratio of ARMIS trench miles to model route miles.

[490] *Inputs Further Notice* at para. 49.

each of these has its own biases and, therefore, that neither is a reasonable alternative to what we have proposed. In brief, US West's first algorithm takes the geometric mean of the national default and a structure ratio to determine the plant mix factor. It defines the structure ratio for underground plant as the ratio of ARMIS trench miles to model route miles; for buried and aerial plant the structure ratio is defined as the relative sheath miles of the structure type multiplied by the model route miles less the ARMIS trench miles. We find that the final result of this algorithm places too much underground structure because, for all but the lowest density zone, the underground plant mix factor is significantly higher than the ARMIS ratio. The second algorithm US West proposes starts with the relative share of ARMIS sheath miles for all three structure types. It then establishes two series of fractions that sum to one. In the first series, the fractions increase as the density zone increases. This series is applied to underground structure and thus places more underground structure in the higher density zones. In the second series, the fractions decrease as the density zones increase. This series is applied to aerial structure, with the result that the percentage of aerial cable declines as density increases. For buried structure, the ARMIS ratio is used for all density zones. We find that this algorithm is flawed because it does not recognize the difference between sheath and route miles. As a consequence, the algorithm produces a biased result. Specifically, it constructs too much underground cable. We find that, until this problem is resolved, relying directly on ARMIS information leads to unreasonable results.

236. Distribution Plant. We adopt the proposed input values for distribution plant mix which are set forth in Appendix A. We conclude that these values for the lowest to the highest density zones, which range from zero percent to 90 percent for underground plant; 60 to zero percent for buried plant; and 40 to ten percent for aerial plant, are the most reasonable estimates of distribution plant mix on the record before us.

237. There is divergence among the commenters with regard to the appropriateness of the input values for the distribution plant mix proposed in the *Inputs Further Notice*. SBC supports the proposed distribution plant mix, noting that it "closely aligns with the embedded plant and future outside plant design."[491] AT&T and MCI advocate the use of the HAI default values for plant mix because, according to AT&T and MCI, they more properly reflect the use of aerial and underground cable than the proposed distribution plant mix inputs.[492] AT&T and MCI claim that the proposed inputs reflect too much underground and too little aerial cable. As we explained in the *Inputs Further Notice*, the model does not design outside plant that contains either riser cable or block cable. Accordingly, use of the HAI default values, which assume a high percentage of aerial plant in densely populated areas, would be inconsistent with the model platform. AT&T and MCI ignore this fact.

[491] SBC *Inputs Further Notice* comments at 11.

[492] AT&T and MCI *Inputs Further Notice* comments at 25.

238. In the *Inputs Further Notice,* we stated that we disagreed with HAI's assumption that there is very little underground distribution plant and none in the six lowest density zones.[493] In support of the HAI values for underground distribution plant, AT&T and MCI proffer the distribution plant mix values for BellSouth, notably the only company to provide such data, showing that its underground distribution plant mix value is very low. We find that, because we are not adopting a company-specific algorithm, it is not necessary to address this issue. As noted above, we will not adopt an alternative algorithm until the issue of underground structure distances has been resolved. We adhere to employing a national value because we find that, though it may not be exact for every company, it will be reasonable for all companies.

239. Feeder Plant. We also adopt the proposed input values for feeder plant mix which are set forth in Appendix A. We conclude that these values for the lowest to the highest density zones, which range from five percent to 95 percent for underground plant; 50 to zero percent for buried plant; and 45 to five percent for aerial plant, are the most reasonable estimates of distribution plant mix on the record before us. GTE's and Sprint's comments specifically address the specific issue of feeder plant mix inputs. As noted above, both carriers advocate the use of company-specific data for plant mix.[494] We reject the use of such data for feeder plant mix for the reasons we enumerate above.

240. Finally, we affirm our tentative conclusion that the plant mix ratios should not vary between copper feeder and fiber feeder. In reaching our tentative conclusion, we noted that, although the HAI sponsors proposed plant mix values that vary between copper feeder and fiber feeder, they have offered no convincing rationale for doing so. We find such support still lacking. GTE claims that a distinction is necessary because the existing plant mix indicates that the trend for more out-of-sight construction has already resulted in differing copper and fiber feeder plant mixes.[495] In contrast, SBC contends that plant mix ratios should not vary between copper feeder and fiber feeder because existing structure is used whenever available for fiber and copper placement so the mix ratio would not differ.[496] We find neither of these claims to be persuasive. Accordingly, we conclude that, given the absence of controverting evidence, it is reasonable to assume that plant mix ratios should not vary between copper feeder and fiber feeder in the model.

D. Structure Sharing

[493] *Inputs Further Notice* at para. 119.

[494] GTE *Inputs Further Notice* comments at 58; Sprint *Inputs Further Notice* comments at 34.

[495] GTE *Inputs Further Notice* comments at 59.

[496] SBC *Inputs Further Notice* comments at 11.

1. Background

241. Outside plant structures are generally shared by LECs, cable operators, electric utilities, and others, including competitive access providers and interexchange carriers. To the extent that several utilities place cables in common trenches, or on common poles, it is appropriate to share the costs of these structures among the various users and assign a portion of the cost of these structures to the telephone company.

242. In the *Inputs Further Notice*, the Commission tentatively adopted structure sharing values for aerial, buried, and underground structure.[497] Several comments relating to these values were filed in response to the *Inputs Further Notice*. Both the BCPM and HAI models varied the percentage of costs they assume will be shared depending on the type of structure (aerial, buried, or underground) and line density.[498] Commenters differ significantly, however, on their assumptions as to the extent of sharing and, therefore, the percentage of structure costs that should be attributed to the telephone company in a forward-looking cost model.[499]

2. Discussion

243. We adopt the following structure sharing percentages that represent what we find is a reasonable share of structure costs to be incurred by the telephone company. For aerial structure, we assign 50 percent of structure cost in density zones 1-6 and 35 percent of the costs in density zones 7-9 to the telephone company.[500] For underground and buried structure, we assign 100 percent of the cost in density zones 1-2, 85 percent of the cost in density zone 3, 65 percent of the cost in density zones 4-6, and 55 percent of the cost in density zones 7-9 to the telephone company.[501] In doing so, we adopt the sharing percentages

[497] *Inputs Further Notice* at para. 129.

[498] *See* HAI Dec. 11, 1997 submission, Appendix B at 57; BCPM Jan. 31, 1997 submission, Attachment 9. The BCPM sponsors assume that an efficient telephone company will benefit only marginally from sharing. The HAI sponsors assume that utilities will engage in substantial sharing with telephone companies, and generally assigns between 25% and 50% of the cost of shared facilities to the LEC.

[499] *See, e.g.*, AT&T/MCI *Inputs Further Notice* comments at 28-31; Bell Atlantic *Inputs Further Notice* comments at 18; GTE *Inputs Further Notice* comments at 57; SBC *Inputs Further Notice* comments at 11.

[500] The model uses nine density zones, ranging from the lowest density zone (1) to the highest density zone (9). The nine density zones (measured in terms of the number of lines per square mile) are as follows: (1) zero - 4.99; (2) 5 - 99.99; (3) 100 - 199.99; (4) 200 - 649.99; (5) 650 - 849.99; (6) 850 - 2549.99; (7) 2550 - 4999.99; (8) 5000 - 9,999.99; (9) 10,000+.

[501] *See* Appendix A for a complete list of the input values that we adopt in this Order.

we proposed in the *Inputs Further Notice*, except for buried and underground structure sharing in density zones 1 and 2, as explained below.

244. Commenters continue to diverge sharply in their assessment of structure sharing.[502] As noted by US West, "[s]ince forward-looking sharing percentages for replacement of an entire network are not readily observable, there is room for reasonable analysts to differ on the precise values for those inputs."[503] While commenters engage in lengthy discourse on topics such as whether the model should assume a "scorched node" approach in developing structure sharing values, little substantive evidence that can be verified has been added to the debate.[504] AT&T and MCI contend that the structure sharing percentages proposed in the *Inputs Further Notice* assign too much of the cost to the incumbent LEC and fail to reflect the greater potential for sharing in a forward-looking cost model.[505] In contrast, several commenters contend that the proposed values assign too little cost to the incumbent LEC and reflect unrealistic opportunities for sharing.[506] In support of this contention, some LEC commenters propose alternative values that purport to reflect their existing structure sharing percentages, but fail to substantiate those values. SBC, however, claims that the structure sharing percentages we propose reflect its current practice and concurs with the structure sharing values that we adopt in this Order.[507]

[502] *See, e.g.*, AT&T/MCI *Inputs Further Notice* comments at 28-31; Bell Atlantic *Inputs Further Notice* comments at 18; GTE *Inputs Further Notice* comments at 57; SBC *Inputs Further Notice* comments at 11.

[503] US West *Inputs Further Notice* comments at 28.

[504] In general, the "scorched node or utilities" debate concerns whether the model should assume that all utilities are non-existent in developing structure sharing percentages. Commenters contend that if the model assumes that everything is in place except for the telecommunications network, then the sharing percentages used in the model should reflect fewer opportunities for sharing because it would not be possible to coordinate sharing with other utilities in the development of a new network. In particular, opportunities for sharing of underground and buried structure would be limited. *See* BellSouth *Inputs Further Notice* comments at 8-9; GTE *Inputs Further Notice* comments at 18-21; US West *Inputs Further Notice* comments at 28-29. While this may provide an interesting topic for academic debate, we do not believe it to be particularly useful or relevant in determining the structure sharing values in this proceeding. We note that, as part of the logical argument that the entire telephone network is to be rebuilt, it is also necessary to assume that the telephone industry will have at least the same opportunity to share the cost of building plant that existed when the plant was first built. We also note that cable and electric utilities continue to deploy service to new customers and replace existing technologies which provides an opportunity for carriers to share structure.

[505] AT&T/MCI *Inputs Further Notice* comments at 28.

[506] *See, e.g.*, BellSouth *Inputs Further Notice* comments, Attachment B at B-13; Sprint *Inputs Further Notice* comments at 36-39; US West *Inputs Further Notice* comments at 29-32.

[507] SBC *Inputs Further Notice* comments at 11.

245. More than with other input values, our determination of structure sharing percentages requires a degree of predictive judgement. Even if we had accurate and verifiable data with respect to the incumbent LECs' existing structure sharing percentages, we would still need to decide whether or not those existing percentages were appropriate starting points for determining the input values for the forward-looking cost model.[508] AT&T and MCI argue that past structure sharing percentages should be disregarded in predicting future structure sharing opportunities. Incumbent LEC commenters argue that sharing in the future will be no more, and may be less, than current practice.

246. In the *Inputs Further Notice*, we relied in part on the deliberations of a state commission faced with making similar predictive judgment relating to structure sharing.[509] The Washington Utilities and Transportation Commission, conducted an examination of these issues and adopted sharing percentages similar to those we proposed.[510]

247. In developing the structure sharing percentages adopted in this Order, we find the sharing percentages proposed by the incumbent LECs to be, in some instances, overly conservative. While we do not necessarily agree with AT&T and MCI as to the extent of available structure sharing, we do agree that a forward-looking mechanism must estimate the structure sharing opportunities available to a carrier operating in the most-efficient manner. As discussed in more detail in this Order, the forward-looking practice of a carrier does not necessarily equate to the historical practice of the carrier.[511] Given the divergence of opinion on this issue, and of AT&T and MCI's contention that further sharing opportunities will exist in the future, we have made a reasonable predictive judgment, and also anticipate that this issue will be revisited as part of the Commission's process to update the model in a future proceeding.

248. In the 1997 *Further Notice*, the Commission tentatively concluded that 100 percent of the cost of cable buried with a plow should be assigned to the telephone

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[508] In contrast, when developing inputs for tangible components of the network, we generally begin our analysis with an estimation of the cost of today's technology at today's prices.

[509] *Inputs Further Notice* at para. 130.

[510] *See* Washington USF Proceeding, Tenth Supplemental Order, Docket No. UT-980311(a) at para. 108. *See also* Washington Utilities and Transportation Commission, Eighth Supplemental Order, Docket No. UT-960369 at paras. 73-76 (1998).

[511] *See* Washington Utilities and Transportation Commission, Eighth Supplemental Order, Docket No. UT-960369 (1998) at para. 73 (proposing a range of sharing values "which reflects the balance between maximum achievable structure sharing and the amount of structure sharing achieved historically.").

company.[512] In the *Inputs Further Notice*, we sought comment on the possibility that some opportunities for sharing existed for buried and underground structure in the least dense areas and proposed assignment of 90 percent of the cost in density zones 1-2 to the telephone company.[513] Several commenters contend that there are minimal opportunities for sharing of buried and underground structure, particularly in lower density areas.[514] In addition, several commenters contend that, to the extent sharing is included in the RUS data, it is inappropriate to count that sharing again in the calculation of structure cost.[515] While we agree that structure sharing should not be double counted, we note that the RUS data includes little or no sharing of underground or buried structure in density zones 1-2.[516] This does, however, support the contention of commenters that there is, at most, minimal sharing of buried and underground structure in these density zones.[517] We therefore modify our proposed input value in this instance and assign 100 percent of the cost of buried and underground structure to the telephone company in density zones 1-2.

249. We believe that the structure sharing percentages that we adopt reflect a reasonable percentage of the structure costs that should be assigned to the LEC. We note that our conclusion reflects the general consensus among commenters that structure sharing varies by structure type and density. While disagreeing on the extent of sharing, the majority of commenters agree that sharing occurs most frequently with aerial structure and in higher density zones.[518] The sharing values that we adopt reflect these assumptions. SBC also concurs with our proposed structure sharing values.[519] In addition, as noted above, the Washington Utilities and Transportation Commission has adopted structure sharing values that

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[512] *1997 Further Notice*, 12 FCC Rcd at 18547, para. 80.

[513] *Inputs Further Notice* at paras. 129-132.

[514] *See, e.g.*, Bell Atlantic *Inputs Further Notice* comments at 19; BellSouth *Inputs Further Notice*, Attachment B at B-14; GTE *Inputs Further Notice* comments at 56-57.

[515] Ameritech *Inputs Further Notice* comments at 12; Sprint *Inputs Further Notice* at 38; US West *Inputs Further Notice* comments, Attachment A at 8.

[516] NRRI Study at 30-31.

[517] *See* GTE *Inputs Further Notice* comments at 57; Sprint *Inputs Further Notice* comments at 39 (noting that the RUS data demonstrates that there are few sharing opportunities in rural areas).

[518] *See, e.g.*, HAI Dec. 11, 1997 submission, Appendix B at 57; BCPM Jan. 31, 1997 submission, Attachment 9; Montana State Cost Study at 46-47.

[519] SBC *Inputs Further Notice* comments at 11.

are similar to those that we adopt.[520] We also note that the sharing values that we adopt fall within the range of default values originally proposed by the HAI and BCPM sponsors.

E. Serving Area Interfaces

1. Background

250. A serving area interface (SAI) is a centrally located piece of network equipment that acts as a physical interface between a feeder cable connecting a wire center and neighborhood distribution copper cables.[521] The model includes appropriate investment for SAIs in all serving areas, whether served by copper or fiber feeder cable.

251. As we explained in the *Inputs Further Notice*, both the sponsors of BCPM and HAI submitted default input values for indoor and outdoor SAI costs.[522] In addition, Sprint submitted cost estimates for a 7200 pair indoor SAI.[523] Because the cost of an SAI depends on the cost of its components, we tentatively concluded that, in the absence of contract data between the LECs and suppliers, it was necessary to evaluate the cost of these components.[524] We posted preliminary ranges of SAI input values on the Commission's Web site to elicit comment and empirical data from interested parties on the cost of SAIs.[525] The Bureau also conducted a workshop on December 11, 1998, to discuss the posted preliminary inputs.[526] Accordingly, our analysis began with a review of the data and justifications submitted by the

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[520] *See* Washington USF Proceeding, Docket No. UT-980311(a), Appendix D.

[521] Generally, when a neighborhood is located near a wire center, copper feeder cable, using analog transmission, is deployed to connect the wire center to the SAI. From the SAI, copper cables of varying gauge extend to all of the customer premises in the neighborhood.

[522] *Inputs Further Notice* at para. 134.

[523] *Inputs Further Notice* at para. 134 n. 242 *citing Indoor SAI Cost Analysis,* submitted by Sprint - Local Telecommunications Division, July 30, 1998.

[524] *Inputs Further Notice* at para. 134.

[525] *Workshop Public Notice* at 2. We used BCPM default inputs as the low end of the ranges for both indoor and outdoor SAIs, and Sprint's cost estimates as the high end of the range for indoor SAIs. The high end of the range for outdoor SAIs represented our analysis of state-approved SAI parameters. Our preliminary ranges for SAI costs did not include HAI inputs because staff concluded that HAI had not included all of the materials and splicing required to install this equipment.

[526] *See Common Carrier Bureau Releases Preliminary Common Input Values to Facilitate Selection of Final Input Values for the Forward-Looking Cost Model for Universal Service,* Public Notice, CC Docket Nos. 96-45, 97-160, DA 99-295 (rel. Feb. 5, 1999) (*Preliminary Input Values Public Notice*); *Workshop Public Notice. See also* Preliminary Input Values Handouts, dated December 11, 1998.

HAI sponsors and Sprint regarding the cost of the components that comprise a 7200 pair indoor SAI.[527] Specifically, we reviewed the cost of the following SAI components for a 7200 pair indoor SAI: building entrance splicing and distribution splicing; protectors; tie cables; placement of feeder blocks; placement of cross-connect jumpers/punch down; and placement of distribution blocks. Of these, we tentatively concluded that protector and splicing costs are the main drivers of SAI costs, and cross-connect costs and feeder block and distribution block installation costs greatly contribute to the difference in Sprint's and the HAI proponents' indoor SAI costs.[528]

252. In the *Inputs Further Notice*, we also proposed to determine the costs of the other SAI sizes by extrapolating from the cost of the 7200 pair indoor SAI because we did not have similar component-by-component data for other SAI sizes.[529] We found that this appeared to be a reasonable approach because of the linear relationship between splicing and protection costs, which are the main drivers of cost, and the number of pairs in the SAI.[530]

2. Discussion

253. We affirm our approach to derive the cost of an SAI on the basis of the cost of its components and adopt a total cost of $21,708 for the 7200 pair indoor SAI. We find that there remains an absence of contract data between the LECs and suppliers with regard to SAIs on the record before us.[531] Accordingly, we affirm, as discussed in more detail below, our tentative conclusions with respect to the following issues: (1) the cost per pair for protector material; (2) the appropriate splicing rate and corresponding labor rate; (3) the methodology

[527] We noted that the BCPM defaults do not specify estimates for the cost of SAI components. *Inputs Further Notice* at para. 134 n. 243.

[528] *Inputs Further Notice* at para. 136. *See Inputs Further Notice,* Appendix D, section IV for a breakdown of costs for each component calculated to derive the proposed cost of a 7200 pair DLC.

[529] *Inputs Further Notice* at para. 141.

[530] As we explained in the *Inputs Further Notice*, we relied on HAI data to determine the relationship in cost among the various sizes of SAI. Specifically, we developed a ratio of our proposed cost for a 7200 pair indoor SAI to the cost proposed by HAI. We then proposed to apply this ratio, 2.25, to the values submitted by the HAI sponsors for other sizes of indoor and outdoor SAIs. Applying this factor, we tentatively adopted the cost estimates for indoor and outdoor SAIs. We proposed to use the HAI, rather than BCPM data, in this manner because BCPM had not submitted estimates for all of the SAI sizes used in the model. We noted that using the BCPM data in this way would result in roughly the same cost estimates for indoor and outdoor SAIs. *Inputs Further Notice* at para. 141.

[531] BellSouth and Bell Atlantic submitted SAI costs in their comments. However, neither party provided any support for these values which reflect total SAI costs. *See* BellSouth *Inputs Further Notice* comments at Exhibit 1; Bell Atlantic *Inputs Further Notice* comments, Attachment D at 7.

employed in cross-connecting in a SAI; and (4) the appropriate feederblock and distribution installation rate.

254. Based on the record before us, we conclude that $4 per pair is a reasonable estimate of the cost for protected material. As we explained in the *Inputs Further Notice*, this estimate is based on an analysis of *ex parte* submissions, which is the only evidence we have available to evaluate the cost of SAI components.[532] We also noted that Sprint has agreed that $4 is a reasonable estimate of the cost.[533] SBC and AT&T and MCI concur with our tentative conclusion to adopt the $4 per pair cost.[534] In sum, the record fully supports our conclusion that $4 per pair is a reasonable estimate of the cost for protector material.

255. We also conclude that the record demonstrates that a splicing rate of 250 pairs is reasonable, and adopt it accordingly. As we explained in the *Inputs Further Notice*, the HAI sponsors proposed a splicing rate of 300 pairs per hour, while Sprint argued for a splicing rate of 100 pairs per hour.[535] We believed that HAI's proposed rate was a reasonable splicing rate under optimal conditions, and therefore, we tentatively concluded that Sprint's proposed rate was too low.[536] We noted that the HAI sponsors submitted a letter from AMP Corporation, a leading manufacturer of wire connectors, in support of the HAI rate.[537] We recognized, however, that splicing under average conditions does not always offer the same achievable level of productivity as suggested by the HAI sponsors. For example, splicing is not typically accomplished under controlled lighting or on a worktable. Having accounted for such variables, we proposed a splicing rate of 250 pairs per hour.

256. AT&T and MCI, the proponents of the 300 pairs per hour rate, support our

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[532] *Inputs Further Notice* at para. 134-135.

[533] *See* Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC, dated February 4, 1999 (Sprint Feb. 4, 1999 *ex parte)*.

[534] SBC *Inputs Further Notice* comments at 12. AT&T and MCI support the SAI costs tentatively adopted. AT&T and MCI *Inputs Further Notice* reply comments at 28.

[535] *Inputs Further Notice* at para. 138 n. 250 *citing* Letter from Chris Frentrup, MCI WorldCom, to Magalie Roman Salas, FCC, dated January 21, 1999; Letter from Kenneth T. Cartmell, U S West, dated February 8, 1999, to Magalie Roman Salas, FCC; Letter from Pete Sywenki, Sprint, to Magalie Roman Salas, FCC dated February 4, 1999. On January 20, 1999, the sponsors of HAI provided a demonstration of splicing, in support of their splicing rate.

[536] *Inputs Further Notice* at para. 138.

[537] *Inputs Further Notice* at para. 138 n. 251 *citing* attachment to letter from Chris Frentrup, MCI WorldCom, to Magalie Roman Salas, FCC, dated January 21, 1999.

tentative conclusion.[538] Sprint takes issue with the splicing rate we proposed.[539] Sprint impugns the evidence, appearing in the form of a letter from AMP Corporation on which we relied in part, to determine a reasonable splicing rate.[540] In sum, Sprint contends the letter represents an "unsupported claim of someone trying to sell equipment."[541] While Sprint is correct that the proponent is an equipment manufacturer, neither Sprint nor any other commenter provided evidence from any other equipment manufacturer to refute AMP.

257. Sprint also questions the fact that we did not utilize the data available from the NRRI Study to determine the splicing rate.[542] Sprint maintains that an analysis of that data results in a splicing rate of 58.8 pairs per hour, substantially less than the 300 pairs per hour we recognized as a ceiling in our analysis. We based our proposed splicing rate on an analysis of such rates as they relate specifically to the installation of a complete and functional SAI. In contrast, although the data to which Sprint refers is for modular splicing, it is not clear, nor does Sprint claim, that such data specifically relates to the installation of SAIs. In sum, the validity of this data as a measure in the derivation of splicing rates for SAI installation is not established on the record. Sprint's critique ignores this fact. Accordingly, we reject the use of the data available from the NRRI Study to determine the splicing rate.

258. We also conclude that the $60 per hour labor rate we proposed for splicing is reasonable and adopt it accordingly. Those commenters addressing this specific issue agree.[543] As we explained in the *Inputs Further Notice*, this rate, which equates with the prevalent labor rate for mechanical apprentices, is well within the range of filings on the record.[544]

259. We also conclude that the model should assume that a "jumper" method will be used half the time and a "punch down" method will be used the remainder of the time to cross-connect an SAI. A cross-connect is the physical wire in the SAI that connects the feeder and distribution cable.

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[538] AT&T and MCI *Inputs Further Notice* reply comments at 29.

[539] In its February 9 *ex parte* noted above, US West proposed a splicing rate of 150 pairs per hour, slightly higher than Sprint's proposed rate.

[540] Sprint *Inputs Further Notice* comments at 40. The letter from AMP Corporation was submitted by the HAI sponsors. *See Inputs Further Notice* at para. 138 n. 251.

[541] Sprint *Inputs Further Notice* comments at 40.

[542] Sprint *Inputs Further Notice* comments at 40.

[543] *See e.g.*, SBC *Inputs Further Notice* comments at 12; AT&T and MCI *Inputs Further Notice* reply comments at 28.

[544] *Inputs Further Notice* at para. 138.

260. In the *Inputs Further Notice*, we tentatively concluded that neither the jumper method nor the punch down method is used exclusively in SAIs.[545] We reached this tentative conclusion based on the conflicting assertions of Sprint and the HAI sponsors. We noted that, Sprint asserted that the "jumper" method generally will be employed to cross-connect in a SAI.[546] In contrast, the HAI sponsors claimed that the "punch down" method is generally used to cross-connect.[547] We also noted that, in buildings with high churn rates, such as commercial buildings, carriers may be more likely to use the jumper method. On the other hand, in residential buildings, where changes in service are less likely, carriers may be more likely to use the less expensive punch down method. Thus, we tentatively concluded that it appeared that both methods are commonly used, and that neither is used substantially more than the other.[548]

261. Based on the record before us, we affirm our tentative conclusion to assume that the "jumper" method and the "punch down" method will be used an equal portion of the time.[549] SBC challenges this conclusion, pointing out that it uses the "jumper" method in applications involving hard lug or insulation displacement contact and that it is currently replacing existing "punch down" interfaces.[550] We conclude that SBC's sole claim is not sufficient to demonstrate that the "jumper" method is used substantially more than the "punch down" method. We note also that Sprint contends that the cross-connect proposed by AT&T and MCI is not an SAI, but a building entrance terminal.[551] We disagree. The design meets the SAI definition of providing an interface between distribution and feeder facilities. In sum, we find that the record demonstrates that it is reasonable for the model to assume that a "jumper" method will be used half the time and a "punch down" method will be used the remainder of the time to cross-connect an SAI.

262. We also adopt a feeder block and distribution installation rate of 200 pairs per hour. As we explained in the *Inputs Further Notice*, we derived this installation factor based

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[545] *Inputs Further Notice* at para. 139.

[546] *Inputs Further Notice* at para. 139.

[547] *Inputs Further Notice* at para. 139.

[548] *Inputs Further Notice* at para. 139.

[549] *See Inputs Further Notice*, Appendix D, section IV to see how this conclusion is used to determine proposed costs for a 7200 pair SAI.

[550] SBC *Inputs Further Notice* comments at 12.

[551] Sprint *Inputs Further Notice* comments at 40-41.

on a comparison of Sprint's proposed installation rate of 60 pairs per hour with HAI's proposed 400 pair per hour rate.[552] We concluded that, because neither feeder block installation nor distribution block installation is a complicated procedure, Sprint's rate of 60 pairs per hour is too low. We also recognized that installation conditions are not always ideal. As we explained, feeder block and distribution block installations are not typically accomplished under controlled lighting or on a worktable. We proposed a rate of 200 pairs per hour to recognize these variables.[553]

263. We note that our proposed feeder block and distribution block rates are unchallenged. Significantly, SBC attests that this installation rate aligns with time-in-motion studies performed in cross-connect building applications.[554] We conclude, therefore, that our proposed rate is reasonable, and adopt input values based upon it accordingly.

264. We also adopt the cost estimates for other size indoor and outdoor SAIs tentatively adopted in the *Inputs Further Notice*.[555] We conclude that, based on the record before us, the derivation of the costs of the other SAI sizes from the cost of the 7200 pair indoor SAI is reasonable.

265. GTE takes issue with the derivation of the costs of the other SAIs from the cost of the 7200 pair indoor SAI.[556] First, GTE contends that there is no need to extrapolate the costs of other SAIs because the costs of individual SAI sizes and associated labor are readily available.[557] We disagree. We concluded that it was necessary to extrapolate the costs of other SAI sizes from the cost of a 7200 pair SAI because of the lack of component-by-component data for other SAI sizes on the record. As noted above, we find the record still lacks such data. We also disagree with GTE's contention that SAI costs are not subject to a linear relationship across all sizes as we determined.[558] We find GTE's contention, which relies on GTE's SAI estimates, unpersuasive given the lack of substantiating data supporting

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552 *Inputs Further Notice* at para. 140.

553 *See Inputs Further Notice*, Appendix D, section IV to see how this value is used in the calculation of a 7200 pair SAI.

554 SBC *Inputs Further Notice* comments at 12.

555 *Inputs Further Notice* at para. 141. These cost estimates are contained in Appendix A of the *Inputs Further Notice*.

556 GTE *Inputs Further Notice* comments at 61.

557 GTE *Inputs Further Notice* comments at 61.

558 GTE *Inputs Further Notice* comments at 61.

these estimates.[559] In sum, the record demonstrates that the derivation of the costs of the other SAIs from the cost of the 7200 pair indoor SAI is reasonable.

266. US West contends that the costs of a SAI should be determined by the actual cable sizes for the cables entering and leaving the SAI rather than the number of cable pairs entering and leaving the interface.[560] We agree. The model has been revised to calculate the costs of an SAI on the basis of actual cable sizes for the cables entering and leaving the SAI.

267. US West raises an additional issue concerning the sizing of SAIs. US West notes that some clusters created by the clustering module exceed the default line limit of 1800 lines and gives as an example a specific cluster containing 7,900 lines.[561] The largest SAI can accommodate only 7200 lines, counting both feeder side and distribution side lines. Therefore, US West contends that, in situations such as this, insufficient SAI plant is deployed by the model. We agree with this analysis. There is no way to guarantee that the line limit of 1800 lines will not be exceeded for some clusters, even though modifications have been made to the cluster algorithm to mitigate this possibility to the greatest possible extent. Therefore, in the current version of the model, we modify the input table for SAI costs so as to allow for serving areas (clusters) in which the capacity of feeder cable plus distribution cable meeting at the interface may exceed 7200. We do this by allowing for line increments of 1800 up to a total line capacity of 28,800. The values in the input table assume that, whenever more than 7200 lines are required in an SAI, two or more standard SAIs are built, one with full capacity of 7200 and the others with capacities equal to 1800, 3600, 5400 or 7200. The input values for each of the multiply-placed SAIs are then summed.

268. A related issue is raised by US West with respect to drop terminal capacity in the model.[562] In previous versions of the model, drop terminals were sized for residential housing units and small business locations, with a maximum line capacity per drop location equal to 25 lines. For medium size and larger business locations with line demand greater than 25 lines, no specific provision for additional drop terminal capacity was provided, except in situations in which a single business accounted for all of the lines in a single cluster. Again, we agree with the US West analysis of this issue. Accordingly, we have modified the input table for drop terminal costs by adding additional line sizes equal to 50, 100, 200, 400,

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[559] We note that in contrast to GTE's claim, the SAI costs reflected in BellSouth's comments reflect linearity.

[560] US West *Inputs Further Notice* comments at 15-16.

[561] US West *Inputs Further Notice* comments at 14; US West *Inputs Further Notice* comments at 16; Letter from Kenneth T. Cartmell, US West, to Magalie Roman Salas, FCC, dated September 24, 1999 (US West September 24 *ex parte*) at 12.

[562] US West September 24 *ex parte* at 12.

600, 900, 1200, 1800, 2400, 3600, 5400, and 7200. At any location requiring a drop terminal with capacity exceeding 25 lines, the model will assume that the location will be served by an indoor SAI, and the cost of the corresponding interface is equal to the corresponding value from the table for SAI costs.

F. Digital Loop Carriers

1. Background

269. A digital loop carrier (DLC) is a piece of network equipment that converts an optical digital signal carried on optical fiber cable to an analog, electrical signal that is carried on copper cable and is compatible with customers' telephones.[563] Because of the high cost of DLCs, a single DLC is shared among a number of customers where possible. The model uses fiber cable and DLCs whenever it calculates that this configuration is cheaper than using copper cable or when the distance between the customer and the wire center exceeds the maximum copper loop length. When using DLCs, the model determines the size and number of DLCs that should be installed at a location, based on cost minimization and engineering constraints. In designing outside plant, the model uses five different sizes of DLCs.[564] In order to run the model, a user must input the fixed and per-line cost for each of these DLC sizes. The total cost of a particular DLC is determined by multiplying the number of lines connected to the DLC times the per-line cost of the DLCs, and then adding the fixed cost of the DLC.

270. In the *Inputs Further Notice*, we tentatively concluded that we should estimate the costs for DLCs based on an average of the contract data submitted on the record, adjusted for cost changes over time.[565] These contract data included data submitted to the Commission in response to the *1997 Data Request*,[566] and in *ex parte* submissions following the December

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563 Optical fiber cable carries a digital signal that is incompatible with most customers' telephone equipment, but the quality of the signal degrades less with distance compared to a signal carried on copper wire. Generally, when a neighborhood is located too far from the wire center to be served by copper cables alone, an optical fiber cable will be deployed to a point within the neighborhood, where a DLC will be placed to convert incoming digital signals to analog signals and outgoing analog signals to digital. From the DLC, copper cables of varying gauge extend to all of the customer premises in the neighborhood.

564 The current version of the model supports a fifth DLC size in addition to those already supported. DLC capacities currently supported are 2016, 1344, 672, 96, and 24 line facilities.

565 *Inputs Further Notice* at para. 144.

566 In response to the *1997 Data Request*, Ameritech, Bell Atlantic (including NYNEX), BellSouth, SBC, US West, GTE, Sprint, ATU, and PRTC originally submitted data to the Commission on DLC costs in 1997. Bell South, US West and ATU resubmitted their data on the record of this proceeding subject to the *Protective Order*. *See* Letter from William W. Jordan, BellSouth, to Magalie Roman Salas, FCC, dated March 15, 1999;

11, 1998 workshop we sponsored, to estimate the costs of DLCs in the model.[567] We found these data to be the most reliable proffered at that time.[568] We rejected use of the BCPM and HAI default values because these values are based on the opinions of experts without data to enable us to substantiate those opinions.[569] Additionally, we rejected data submitted by the HAI sponsors following the workshop.[570] We found the data submitted by the HAI sponsors to be significantly lower than the contract data on the record, and concluded that it would be inappropriate to use the data submitted by the HAI sponsors, especially as no support was provided to justify use of the data.[571]

271. In reaching our tentative conclusion to use the contract data, we noted that, although we would have preferred to have a larger sampling of data, the contract data represent the costs incurred by several of the largest non-rural carriers, as well as two of the smallest non-rural carriers.[572] We noted that, throughout this proceeding, the Commission had repeatedly requested cost data on DLCs, largely to no avail.[573] Finally, we stated our belief that the data on which we relied was the best data available on the record to determine the cost of DLCs.[574]

Letter from Robert B. McKenna, US West, to Magalie Roman Salas, FCC, dated March 8, 1999; Letter from Alane C. Weixel, counsel for ATU, to Magalie Roman Salas, FCC, dated May 6, 1999 (ATU May 6, 1999 *ex parte*).

[567] Letter from W. Scott Randolph, GTE, to Magalie Roman Salas, FCC, dated February 11, 1998; Letter from Robert A. Mazer and Albert Shuldiner, Counsel for Aliant, to Magalie Roman Salas, FCC, dated February 8, 1998.

[568] *Inputs Further Notice* at para. 143.

[569] *Inputs Further Notice* at para. 143.

[570] *Inputs Further Notice* at para. 144.

[571] *Inputs Further Notice* at para. 144.

[572] *Inputs Further Notice* at para. 144.

[573] *Inputs Further Notice* at para. 144. In addition to the data submitted in response to the *1997 Data Request*, and following the December 11, 1998, workshop, the Bureau requested further data on DLC costs in the *1997 Further Notice* and in the *Inputs Public Notice*. *See also Preliminary Input Values Public Notice*.

[574] *Inputs Further Notice* at para. 144. Only US West, BellSouth, and ATU presented their contract data from the *1997 Data Request* in a useable format Some of the data and comments that were submitted in response to the *1997 Data Request*, but not re-filed on the record under the *Protective Order*, could not be used because the data were either inadequate or presented in a format from which we could not extract relevant information. *Inputs Further Notice* at para. 144 n. 262.

272. In the *Inputs Further Notice*, we also recognized that the cost of purchasing and installing a DLC changes over time.[575] We explained that such changes occur because of improvements in the methods and components used to produce DLCs, changes in both capital and labor costs, and changes in the functionality requirements of DLCs. Accordingly, we tentatively concluded that it is appropriate to adjust the contract data, which represents the years 1995-1998, to reflect 1999 prices.[576] We proposed a 2.6 percent annual reduction in both fixed DLC cost and per-line DLC cost in order to capture changes in the cost of purchasing and installing DLCs over time.[577] We based this rate on the change in cost calculated for electronic digital switches over a four year period. We noted our belief that the change in the cost of these switches over time is a reasonable proxy for changes in DLC cost, because they are both types of digital telecommunications equipment. We also noted that the 2.6 percent figure is a conservative estimate, based on the change in cost of remote switches. Our analysis suggested that the change in cost of host switches over the past four years is much higher. Finally, we noted that use of the current consumer price index results in a similar figure over four years.[578] The indexed amount is based on the effective date of the contracts.

273. Finally, we also sought comment on the extent, if any, to which we should increase our proposed estimates for DLCs to reflect material handling and shipping costs.[579] We did this in response to comments submitted by ATU. It was unclear whether the DLC data submitted by other parties included these costs. ATU suggested that these costs could represent up to 10 percent of the material cost of a DLC.[580]

2. Discussion

274. We adopt an average of the contract data submitted on the record, adjusted for cost changes over time, as the cost estimates for DLCs. This decision is predicated on two conclusions. The first is our determination that the contract data submitted to the Commission in response to the *1997 Data Request*, and in *ex parte* submissions following the December

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[575] *Inputs Further Notice* at para. 145.

[576] *Inputs Further Notice* at para. 146.

[577] *Inputs Further Notice* at para. 146.

[578] *Inputs Further Notice* at para. 146.

[579] *Inputs Further Notice* at para. 145.

[580] ATU May 6, 1999 *ex parte*. ATU also suggested that costs for placement, installation, and testing should be added to the DLC material costs it submitted. We note that these site preparation costs are already separately accounted for in the model.

11, 1998, workshop, remains the most reliable data on the record. Significantly, no additional information has been proffered nor has any alternative method been proposed, on which to base our estimate of DLC costs. The second is that we conclude that it is reasonable to reduce both the fixed DLC cost and per-line DLC cost reflected in this data by a factor of 2.6 percent per year in order to capture changes in the cost of purchasing and installing DLCs over time.

275. As we explained in the *Inputs Further Notice*, the contract data submitted to the Commission in response to the *1997 Data Request*, and in *ex parte* submissions following the December 11, 1998, workshop, is the most reliable data because, not only is it the only data on the record, but it reflects the actual costs incurred in purchasing DLCs.[581] Moreover, although we would have preferred a larger sample, the contract data is sufficiently representative of non-rural carriers because it reflects the costs incurred by several of the largest non-rural carriers, as well as two of the smallest non-rural carriers.

276. GTE, Bell Atlantic and Sprint support the use of the contract data in estimating the cost of DLCs.[582] Only AT&T and MCI and SBC challenge the use of these data.[583] SBC contends that the contract data is not the most reliable data on DLC costs because labor costs associated with testing, turn-up, and delivery of derived facilities are not factored into the input values.[584] We disagree. The data we identify as "contract data" include these costs. As we explained in the *Inputs Further Notice* and noted above, we sponsored a workshop on December 11, 1998, to further develop the record on DLC costs in this proceeding. During the workshop, we presented a template of the components of a typical DLC to the attendees. The template provided the respondents the opportunity to identify their contract costs with regard to each of the components. In addition, we requested that the respondents identify, and thereby include, other costs associated with DLC acquisition, including labor costs associated with testing, turn-up, and delivery of the DLC. Using this opportunity to submit DLC cost data, GTE and Aliant included such costs in their submissions. Sprint submitted similar data in a September 9, 1998 *ex parte* filing. These costs were identified and added to the analysis of US West's and BellSouth's contract data. We derived these costs from *ex parte* filings made by these carriers in this proceeding.

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581 *Inputs Further Notice* at para. 143.

582 GTE *Inputs Further Notice* comments at 62; Bell Atlantic *Inputs Further Notice* comments, Attachment D at 8-9, Chart 12. Sprint attests to the reasonableness of the proposed inputs based on the contract data. Sprint *Inputs Further Notice* comments at 41. Sprint explains that it demonstrated in a June 24, 1999 *ex parte* that the proposed inputs are in line with Sprint's actual costs including material and handling.

583 AT&T and MCI *Inputs Further Notice* comments at 32-35 (Proprietary Version); SBC *Inputs Further Notice* comments at 13.

584 SBC *Inputs Further Notice* comments at 13.

277. AT&T and MCI allege that the contract data overstates the actual costs of DLC equipment and therefore, should not be adopted.[585] AT&T and MCI instead advocate use of the HAI default values.[586] AT&T and MCI argue that the contract costs are not only unsupported by any verifiable evidence but, more importantly, are refuted by the contract information from which they were derived. In support, AT&T and MCI submit an analysis of the DLC cost submissions of Bell Atlantic, BellSouth, and Sprint. In each instance, AT&T and MCI assert that these data demonstrate DLC costs that are far below those proposed by the incumbent LECs and the Commission and that are fully consistent with the HAI default values.

278. We disagree with AT&T and MCI's analysis. For example, AT&T and MCI claim that information provided by Bell Atlantic shows that total DLC common equipment costs for DLC systems capable of serving 672, 1344, and 2016 lines are similar to, and uniformly less than, the corresponding HAI values.[587] In reaching this conclusion, however, AT&T and MCI omit the costs for line equipment. As Bell Atlantic points out, the cost of digital line carrier equipment should include these costs, and we agree.[588]

279. Similarly, AT&T and MCI assert that certain of Sprint's costs are significantly inflated and, once adjusted, are similar to and uniformly less than the corresponding HAI values.[589] We find, however, these adjustments to be unsupported. AT&T and MCI reduce the supply expenses associated with Sprint's DLC costs, more than 66 percent, based on the experience of AT&T and MCI's engineering team members.[590] AT&T and MCI offer no evidence, however, other than the opinions of their experts to substantiate this proposed adjustment.

280. AT&T and MCI also contend that Sprint applies excessive mark-ups for sales tax.[591] AT&T and MCI argue that, because Sprint operates its own logistics company, there is no reason to apply sales tax to both supply expense and materials. We find that AT&T and

[585] AT&T and MCI *Inputs Further Notice* comments at 32-35 (Proprietary Version)

[586] AT&T and MCI *Inputs Further Notice* comments at 34.

[587] AT&T and MCI *Inputs Further Notice* comments at 33-34 (Proprietary Version).

[588] Bell Atlantic *Inputs Further Notice* reply comments 6-7.

[589] AT&T and MCI *Inputs Further Notice* comments at 34.

[590] AT&T and MCI *Inputs Further Notice* comments, Attachment B at B-4 (Proprietary Version)

[591] AT&T and MCI *Inputs Further Notice* comments, Attachment B at B-4 (Proprietary Version).

MCI offer no support to demonstrate that this results in an excessive mark-up for sales tax. We reach the same conclusion with regard to AT&T and MCI's proposed reduction to Sprint's labor costs. AT&T and MCI contend that Sprint's labor costs are inflated and propose reductions in such costs through a reduction in the number of labor hours associated with DLC installation.[592] AT&T and MCI provide no support for such a reduction and, therefore, we decline to reduce Sprint's labor costs.[593]

281. Significantly, AT&T and MCI offer no evidence to controvert our tentative conclusion that the HAI values they employ as a comparative benchmark, and advocate that we adopt, are not more reliable than the contract data. We rejected the use of the HAI and the BCPM default values because they are based on the opinions of experts without substantiating data.[594] Similarly, we rejected data submitted by the HAI sponsors following the December 11, 1998, workshop. We found that data to be significantly lower than the contract data on the record, and concluded that it would be inappropriate to use because it also lacked support.[595] AT&T and MCI have not provided any additional evidence to substantiate the HAI data.

282. We also affirm our tentative conclusion that it is reasonable to reduce both the fixed DLC costs and per-line DLC costs reflected in the contract data in order to capture changes in the cost of purchasing and installing DLCs. As we explained in the *Inputs Further Notice*, this reduction recognizes the fact that the cost of purchasing and installing a DLC diminishes over time because of improvements in the methods and components used to produce DLCs, changes in both capital and labor costs, and changes in the functionality requirements of DLCs.[596] The premise that overall DLC costs move downward over time is not disputed on the record.

283. We also conclude that the 2.6 percent reduction we proposed in both the fixed DLC costs and per-line DLC costs is appropriate. As we explained in the *Inputs Further Notice*, this is a conservative estimate, based on the change in cost of remote switches, which

[592] AT&T and MCI *Inputs Further Notice* comments, Attachment B at B-4 (Proprietary Version).

[593] AT&T and MCI also claim that Sprint fails to make use of forward-looking technology such as GR303-capable hardware. AT&T and MCI *Inputs Further Notice* comments, Attachment B at B-4 (Proprietary Version). Contrary to AT&T and MCI's assertion, the data supplied by Sprint and reflected in the contract data adopted herein reflects the cost of GR303-capable hardware. *See* Sprint Sept. 9, 1998 *ex parte*.

[594] *Inputs Further Notice* at para. 143.

[595] *Inputs Further Notice* at para. 144.

[596] *Inputs Further Notice* at para. 146.

is a reasonable proxy for changes in DLC cost.[597] More importantly, a comparison of data submitted on the record by Sprint for the years 1997, 1998, and 1999 demonstrates that an overall reduction of 2.6 percent is considerably less than Sprint's actual experience. An analysis undertaken by staff produces an average reduction in DLC costs for Sprint of 9.2 percent per year. We note that this estimate reflects both material and labor costs.

284. Only SBC and GTE specifically address the 2.6 percent reduction.[598] SBC supports the 2.6 percent reduction in fixed and per-line DLC costs as it applies to material costs only. In contrast, GTE opposes the adjustment.[599] GTE suggests that, as the inputs are adjusted over time, the cost of current technology will be reflected in the revised data.[600] GTE is correct that the current cost of technology would be reflected in revised data. The adjustment we proposed and adopt updates cost to current cost. Implicit in SBC's comment is the premise that labor costs will not decrease over time. Although this may be a reasonable assumption, the 2.6 percent reduction we adopt is applied to the overall cost of a DLC. As we explained above, the 2.6 percent reduction is a conservative estimate compared to the actual reductions we have observed in the Sprint data. As a result, we conclude that increases in labor will be offset by reductions in other factors in the cost of DLCs.

285. Finally, as noted above, we sought comment on the extent, if any, to which we should increase our proposed estimates for DLCs to reflect material handling and shipping costs because it was unclear whether the DLC data submitted by other parties include these costs. On further analysis, we note that material handling and shipping costs are reflected in the proposed DLC estimates we adopt herein. Moreover, we conclude that it is appropriate to include these costs in the cost estimates for DLCs. We note that no comments were filed opposing the inclusion of such costs.

VI. SWITCHING AND INTEROFFICE FACILITIES

A. Introduction

286. The central office switch provides the connection between a subscriber's local loop and the outside world. Modern digital switches connect telephones, fax machines, and

[597] None of the commenters challenge the use of this proxy for estimating the change in DLC costs.

[598] SBC *Inputs Further Notice* comments at 13; GTE *Inputs Further Notice* comments at 61-62.

[599] GTE *Inputs Further Notice* comments at 61-62.

[600] GTE *Inputs Further Notice* comments at 62.